

What Is Claimed Is:

Sub A 1. A system for modular amplification of optical signals in a set of multiple channels in an operating window of a fiber communication network, comprising:
 5 a first multiplexing unit for multiplexing the optical signals in the set of multiple channels into at least one subgroup of optical signals in a respective at least one subwindow within the operating window, each subwindow corresponding to a different group of channels within the operating window; and
 10 at least one optical line amplifier for amplifying said at least one subgroup of optical signals corresponding to said at least one subwindow within the operating window.

Sub D 2. The system of claim 1, wherein the operating window comprises an erbium band of wavelengths between approximately 1520 nm and 1561 nm, and each optical line amplifier includes at least one fiber amplifier.

3. The system of claim 2, wherein said first multiplexing unit multiplexes
 15 the optical signals in the set of multiple channels into first, second, third, and fourth subgroups of optical signals depending upon wavelength in corresponding first, second, third, and fourth subwindows within the operating window,
 said first subwindow includes a first group of channels,
 said second subwindow includes a second group of channels,
 20 said third subwindow includes a third group of channels, and
 said fourth subwindow includes a fourth group of channels.

4. The system of claim 3, wherein:
 said first group of channels comprises channels in a first range of
 wavelengths between approximately 1530 to 1536 nm;
 25 said second group of channels comprises channels in a second range of wavelengths between approximately 1538 to 1543 nm;

~~said third group of channels comprises channels in a third range of wavelengths between approximately 1547 to 1553 nm; and~~

~~said fourth group of channels comprises channels in a fourth range of wavelengths between approximately 1555 to 1561 nm.~~

5 5. The system of claim 4, wherein, the set of multiple channels in the operating window comprises sixteen channels, and said first, second, third and fourth groups of channels each have four channels.

6. The system of claim 3, wherein:
 said first group of channels comprises first to fourth channels;
 said second group of channels comprises fifth to eighth channels;
 said third group of channels comprises ninth to twelfth channels; and
 said fourth group of channels comprises thirteenth to sixteenth channels;
 wherein said first to sixteenth channels support respective optical signals having the following approximate wavelengths:

Channel No.	Approximate Wavelength (nm)
1	1530.33
2	1531.90
3	1533.47
4	1535.04
5	1538.19
6	1539.77
7	1541.35
8	1542.94
9	1547.72
10	1549.32
11	1550.92
12	1552.52

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Channel No.	Approximate Wavelength (nm)
13	1555.75
14	1557.36
15	1558.98
16	1560.61

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7. The system of claim 1, wherein said at least one optical line amplifier comprises a plurality of optical line amplifiers and said first multiplexing unit comprises:

a first coarse wavelength division multiplexing unit for multiplexing the optical signals in the set of multiple channels into first, second, third, and fourth subgroups of optical signals depending upon wavelength in corresponding first, second, third, and fourth subwindows within the operating window; and

first, second, third, and fourth fine wavelength division multiplexing units optically coupled in parallel between said first coarse wavelength division multiplexing unit and said plurality of optical line amplifiers, said first, second, third, and fourth fine wavelength division multiplexing units further multiplex said first, second, third, and fourth subgroups of optical signals by wavelength into channels for carrying optical signals having different wavelengths within corresponding first, second, third, and fourth subwindows.

8. The system of claim 1, further comprising:

a second multiplexing unit for multiplexing the optical signals in the set of multiple channels into said at least one subgroup of optical signals in said respective at least one subwindow within the operating window; and

at least one optical fiber coupled between said first and second multiplexing units, said at least one optical line amplifier being optically coupled to said at least one optical fiber to amplify said at least one subgroup of optical

signals corresponding to said at least one respective subwindow within the operating window.

9. The system of claim 1, wherein said first multiplexing unit comprises a coarse WDM unit and at least one fine WDM unit, whereby fine WDM units can be added to the system in a modular fashion to support channels in respective subwindows as needed.

10. The system of claim 8, wherein said at least one optical fiber comprises at least one single mode optical fiber selected from the following types of single-mode optical fiber: non-dispersion-shifted optical fiber, zero-dispersion shifted optical fiber, and low slope dispersion-shifted optical fiber.

11. The system of claim 8, wherein said first and second multiplexing units are arranged at first and second sites, and said at least one optical line amplifier and said at least one optical fiber each transport optical signals traveling in at least one of uni-directional traffic and bi-directional traffic between said first and second sites.

12. The system of claim 1, wherein said at least one optical line amplifier comprises first to fourth optical line amplifiers, said at least one subgroup of optical signals comprises first to fourth subgroups of optical signals in corresponding first to fourth subwindows within the operating window, and further comprising:

a second multiplexing unit for multiplexing the optical signals in the set of multiple channels into said first to fourth subgroups of optical signals in corresponding first to fourth subwindows within the operating window, each subwindow corresponding to a different group of channels within the operating window; and

first to fourth optical fibers arranged in parallel between said first and second multiplexing units, said first to fourth optical line amplifiers being

optically coupled along said first to fourth optical fibers, respectively, to amplify said first to fourth subgroups of optical signals corresponding to said first to fourth subwindows within the operating window;

wherein said first and second multiplexing units are arranged at first and second sites, and said first and third optical line amplifiers and said first and third optical fibers each pass optical signals traveling in a first direction between said first and second sites, and said second and fourth optical line amplifiers and said second and fourth optical fibers each pass optical signals traveling in a second direction between said first and second sites opposite to said first direction.

13. The system of claim 1, wherein each optical line amplifier further includes a dispersion compensation device, whereby, subgroups of optical signals corresponding to respective subwindows within the operating window are amplified for each subwindow to make amplifier gain approximately equal across ~~the channels in the operating window~~.

Sub 14. A method for modular amplification of optical signals in a set of multiple channels in an operating window of a fiber communication network, comprising the steps of:

multiplexing the optical signals in the set of multiple channels into at least one subgroup of optical signals in a corresponding at least one subwindow within the operating window, each subwindow corresponding to a different group of channels within the operating window; and

amplifying said at least one subgroup of optical signals corresponding to said respective at least one subwindow within the operating window.

Sub 15. The method of claim 14, wherein the operating window comprises an erbium band of wavelengths between approximately 1520 nm and 1561 nm having four subwindows, and said multiplexing step multiplexes the optical signals in the set of multiple channels into four subgroups of optical signals in

respective subwindows within the operating window, and said amplifying step amplifies in parallel said four subgroups of optical signals.

5 16. The method of claim 14, wherein said multiplexing step comprises the step of coarse multiplexing the optical signals in the set of multiple channels into first, second, third, and fourth subgroups of optical signals depending upon wavelength in corresponding first, second, third, and fourth subwindows within the operating window,

 said first subwindow includes a first group of channels,

 said second subwindow includes a second group of channels,

10 said third subwindow includes a third group of channels, and

 said fourth subwindow includes a fourth group of channels.

15 ~~17. The method of claim 16, wherein said coarse multiplexing step multiplexes the optical signals in the set of multiple channels into first, second, third, and fourth subgroups of optical signals depending upon wavelength in corresponding first, second, third, and fourth subwindows within the operating window such that:~~

 said first subwindow comprises said first group of channels having optical signals in a first range of wavelengths between approximately 1530 to 1536 nm;

20 said second subwindow comprises said second group of channels having optical signals in a second range of wavelengths between approximately 1538 to 1543 nm;

 said third subwindow comprises said third group of channels having optical signals in a third range of wavelengths between approximately 1547 to 1553 nm; and

25 said fourth subwindow comprises said fourth group of channels having optical signals in a fourth range of wavelengths between approximately 1555 to 1561 nm.

18. ~~The method of claim 17, further comprising the step of fine multiplexing optical signals for each of said first to fourth groups of channels to individual channels within each respective first to fourth subwindows.~~

19. The method of claim 14, wherein said multiplexing step multiplexes optical signals in the operating window into first to sixteenth channels having the following approximate wavelengths:

Channel No.	Approximate Wavelength (nm)
1	1530.33
2	1531.90
3	1533.47
4	1535.04
5	1538.19
6	1539.77
7	1541.35
8	1542.94
9	1547.72
10	1549.32
11	1550.92
12	1552.52
13	1555.75
14	1557.36
15	1558.98
16	1560.61

20. ~~The method of claim 14, wherein said multiplexing step comprises the steps of:~~

performing a first coarse wavelength division multiplexing operation to multiplex the optical signals in the set of multiple channels into first, second, third, and fourth subgroups of optical signals depending upon wavelength in corresponding first, second, third, and fourth subwindows within the operating window; and

performing first, second, third, and fourth fine wavelength division multiplexing operations in parallel to further multiplex said first, second, third, and fourth subgroups of optical signals by wavelength into channels for carrying optical signals having different wavelengths within corresponding first, second, third, and fourth subwindows.

21. The method of claim 14, wherein said multiplexing step is performed at a first site, and further comprising the steps of:

multiplexing at a second site the optical signals in the set of multiple channels in said at least one subgroup of optical signals in said at least one corresponding subwindow within the operating window; and

passing said at least one subgroup of optical signals corresponding to said subwindow within the operating window over an optical path extending between said first and second sites.

22. The method of claim 21, wherein said passing step passes a plurality of said subgroups of optical signals corresponding to said subwindows within the operating window over parallel optical paths comprising a plurality of single-mode optical fibers, and including the step of selecting from the following types of single-mode optical fiber: non-dispersion-shifted optical fiber, zero-dispersion-shifted optical fiber, and low slope dispersion-shifted optical fiber.

23. The method of claim 21, wherein said passing step passes optical signals traveling in at least one of uni-directional traffic and bi-directional traffic between said first and second sites.

24. The method of claim 14, wherein said at least one subgroup of optical signals comprises first to fourth subgroups of optical signals in corresponding first to fourth subwindows within the operating window, and further comprising the steps of:

passing optical signals in said first and third subwindows in a first direction between first and second sites; and

passing optical signals in said second and fourth subwindows in a second direction between first and second sites.

25. The method of claim 24, wherein said multiplexing step comprises the steps of:

multiplexing the optical signals in the set of multiple channels into said first and third subgroups of optical signals in corresponding first and third subwindows within the operating window; and

demultiplexing the optical signals in the set of multiple channels into said second and fourth subgroups of optical signals in corresponding second and fourth subwindows within the operating window.

26. The method of claim 14, further comprising the step of compensating dispersion magnitude separately for each subwindow, whereby, said subgroups of optical signals corresponding to said subwindows within the operating window are amplified for each subwindow to make amplifier gain approximately equal across the channels in the operating window.

27. A system for modular amplification of optical signals in a set of multiple channels in an erbium band operating window of a fiber communication network, comprising:

first and second wavelength division multiplexing units; and
a fiber link optical coupling said first and second wavelength division multiplexing units;

wherein said first and second wavelength division multiplexing units each comprises a coarse WDM unit and at least one fine WDM unit; whereby fine WDM units can be added to the system in a modular fashion to support channels in respective subwindows as needed.

28. The system of claim 27, further comprising, at least one optical line amplifier and dispersion compensation unit provided along each optical fiber in said fiber link, whereby, each optical line amplifier and dispersion compensation unit can be added to the system in a modular fashion to support channels in respective subwindows as needed.

29. A modular wavelength division multiplexing system for multiplexing optical signals in a set of multiple channels within an operating window of a fiber communication network, comprising:

a coarse wavelength division multiplexing unit; and

at least one fine wavelength division multiplexing unit; wherein,

said coarse wavelength division multiplexing unit multiplexes the optical signals into subgroups of optical signals in corresponding subwindows within said operating window, each subwindow corresponding to a different group of channels within said operating window, and

each fine wavelength division multiplexing unit multiplexes the optical signals within a respective subgroup of optical signals into individual channels within in a corresponding subwindow.

30. The system of claim 29, wherein said coarse wavelength division multiplexing unit multiplexes said optical signals into first, second, third, and fourth subgroups of optical signals depending upon wavelength in corresponding first, second, third, and fourth subwindows within said operating window said first subwindow includes a first group of channels,

said second subwindow includes a second group of channels,
 said third subwindow includes a third group of channels, and
 said fourth subwindow includes a fourth group of channels.

31. The system of claim 30, wherein:

said first group of channels comprises channels in a first range of
 wavelengths between approximately 1530 to 1536 nm;

said second group of channels comprises channels in a second range of
 wavelengths between approximately 1538 to 1543 nm;

said third group of channels comprises channels in a third range of
 wavelengths between approximately 1547 to 1553 nm; and

said fourth group of channels comprises channels in a fourth range of
 wavelengths between approximately 1555 to 1561 nm.

32. The system of claim 31, wherein, said set of multiple channels in said
 operating window comprises sixteen channels, and said first, second, third and
 fourth groups of channels each have four channels.

33. The system of claim 32, wherein said at least one fine wavelength division
 demultiplexing units comprises four fine wavelength division demultiplexing units
 that multiplex optical signals in said first to fourth subwindows, respectively, of
 the operating window into first to sixteenth channels having the following
 approximate wavelengths:

Channel No.	Approximate Wavelength (nm)
1	1530.33
2	1531.90
3	1533.47
4	1535.04
5	1538.19
6	1539.77

Channel No.	Approximate Wavelength (nm)
7	1541.35
8	1542.94
9	1547.72
10	1549.32
11	1550.92
12	1552.52
13	1555.75
14	1557.36
15	1558.98
16	1560.61

34. The system of claim 29, wherein:

said coarse multiplexing unit comprises a first coarse wavelength division multiplexing unit for multiplexing said optical signals in said set of multiple channels into first, second, third, and fourth subgroups of optical signals depending upon wavelength in corresponding first, second, third, and fourth subwindows within the operating window; and

said at least one fine wavelength division multiplexing unit comprises first, second, third, and fourth fine wavelength division multiplexing units optically coupled to said first coarse wavelength division multiplexing unit, said first, second, third, and fourth fine wavelength division multiplexing units further multiplexing said first, second, third, and fourth subgroups of optical signals by wavelength into channels for carrying optical signals having different wavelengths within corresponding first, second, third, and fourth subwindows.

35. A modular wavelength division multiplexing method for multiplexing optical signals in a set of multiple channels within an operating window of a fiber communication network, comprising the steps of:

coarse wavelength division multiplexing the optical signals into subgroups of optical signals in corresponding subwindows within said operating window, each subwindow corresponding to a different group of channels within said operating window; and

fine wavelength division multiplexing the optical signals within a respective subgroup of optical signals into individual channels within in a corresponding subwindow.

~~36. The method of claim 35, wherein said coarse wavelength division multiplexing step multiplexes said optical signals into first, second, third, and fourth subgroups of optical signals depending upon wavelength in corresponding first, second, third, and fourth subwindows within said operating window,~~

~~said first subwindow includes a first group of channels,
said second subwindow includes a second group of channels,
said third subwindow includes a third group of channels, and
said fourth subwindow includes a fourth group of channels.~~

37. The method of claim 36, wherein said coarse wavelength division multiplexing step multiplexes said optical signals into first, second, third, and fourth subgroups of optical signals depending upon wavelength in corresponding first, second, third, and fourth subwindows within said operating window such that:

said first group of channels comprises channels in a first range of wavelengths between approximately 1530 to 1536 nm;

said second group of channels comprises channels in a second range of wavelengths between approximately 1538 to 1543 nm;

said third group of channels comprises channels in a third range of wavelengths between approximately 1547 to 1553 nm; and

~~said fourth group of channels comprises channels in a fourth range of wavelengths between approximately 1555 to 1561 nm.~~

38. The method of claim 37, wherein, said set of multiple channels in said operating window comprises sixteen channels, and said coarse wavelength division multiplexing step multiplexes optical signals into said four groups of channels, and said fine wavelength division multiplexing step multiplexes said coarsely multiplexed signals into four channels within each of said four groups of channels.

39. The method of claim 36, wherein said fine wavelength division multiplexing step multiplexes optical signals in said first to fourth subwindows, respectively, of the operating window into first to sixteenth channels having the following approximate wavelengths:

Channel No.	Approximate Wavelength (nm)
1	1530.33
2	1531.90
3	1533.47
4	1535.04
5	1538.19
6	1539.77
7	1541.35
8	1542.94
9	1547.72
10	1549.32
11	1550.92
12	1552.52
13	1555.75
14	1557.36

Channel No.	Approximate Wavelength (nm)
15	1558.98
16	1560.61

40. The method of claim 35, wherein said coarse wavelength division multiplexing step multiplexes said optical signals in said set of multiple channels into first, second, third, and fourth subgroups of optical signals depending upon wavelength in corresponding first, second, third, and fourth subwindows within the operating window; and

said fine wavelength division multiplexing step comprises the steps of further multiplexing in parallel said first, second, third, and fourth subgroups of optical signals by wavelength into channels for carrying optical signals having different wavelengths within corresponding first, second, third, and fourth subwindows.

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